

## **Abstract**

Thesis: Activity-Specific Validity of Several Consumer-Based Physical Activity Monitors

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Degree: Master of Science

Date: May 2015

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Consumer-based PA monitors provide information regarding steps taken, energy expenditure (EE), and active time, which relate specifically to several public health recommendations. However, the validation of consumer-based PA monitors has primarily been concerned with total EE and has not examined how well they perform specific to different types of activities. This study aimed to examine several consumer-based PA monitors in their ability to count steps, estimate EE, and track active time specific to sedentary, household, and ambulatory activities. The effect of hand dominance upon wrist-worn monitors and comparison to a research-grade accelerometer were also examined.

Adult males (N=10) and females (N=10) wore 5 types of activity monitors simultaneously while completing a 70-min structured activity protocol. The monitors worn were the Fitbit One (FO, left hip), Fitbit Zip (FZ, left hip), Fitbit Flex (left and right wrist, FFL and FFR), Jawbone UP24 (left and right wrist, JUL and JUR), and ActiGraph GT3X+ (AG, right hip). Activities consisted of lying down, using computer, watching TV, writing playing cards, reading, standing, dusting, making a bed, folding laundry, sweeping, vacuuming, gardening, picking up items from floor, leisure and brisk overground walking, treadmill walk, stationary cycling, ascending and descending stairs, overground jogging, and treadmill jogging. All subjects performed lying down for 10 min; 10 other activities were performed for 5 min each,

self-paced. EE estimates and step counts for each activity, as well as the total activity protocol, were compared to measured EE by indirect calorimetry (COSMED K4b2) and steps as counted by direct observation (DO). Total active time accrued was compared to active time as measured by the COSMED. Means from monitors were compared to criterion measures using Friedman rank sum for k-samples and pairwise comparisons. Paired t-tests were used to analyze the effect of hand dominance on wrist monitors. Root mean square error (RMSE) was also calculated.

Across the total activity protocol, all monitors tended to underestimate total EE and step counts compared to the criterion measures. Sedentary EE was estimated within 10% of the criterion by all monitors except the JUR. The FO, FZ, JUL, and JUR monitors underestimated EE during household tasks (29-37%), but the FFL and FFR were within 10% of the criterion. All monitors tended to overestimate EE for ambulatory activities (12-40%). EE estimations were accompanied with large RMSE (>10%). The FO and FZ estimated step counts within 2% of the criterion during ambulatory activities (with RMSE of 3-10%), but underestimated steps during household activities by 68-69%. The FFL and FFR were within 10% of DO for step counts during ambulatory and household activities. Total active time was underestimated significantly by the FF and JU monitors, by 23-61%. All monitors performed poorly for cycling, underestimating 40-61% for EE and 79-94% for step counts. The JUL and JUR performed similarly to the AG (using the Freedson et al. MET prediction equation) in underestimation of EE and active time for the entire protocol.

Consumer-based PA monitors have a high degree of error for predicting EE and active time. The FO and FZ monitors are accurate for tracking steps for ambulatory activities but are not accurate for predicting EE for most activities. The FF performed best for predicting overall EE and was also accurate for counting steps across household and ambulatory activities.